densers to concentrate the light of the arc upon the picture gate. The arcs are fed by a special 800-amp., 110-v. generator, and 16-mm. positive and 11-mm. copper-coated negative carbons are used.

To photograph the scenes two cameras are necessary, each taking simultaneously one-half of the picture. Each camera is equipped with a Hypergonar lens. Each half-image is projected simultaneoulsy by the two outside projectors, the right-hand projector projecting the image on the left-half of the screen, and *vice versa*. The junction of the two images is smoothed out by special masks consisting of two stationary shutters, the edges of which are cut like the teeth of a saw and set into the light-beams where the latter superimpose. Each of these stationary shutters was set about one meter in front of each projector, on the left and right, outside the beams. The shutters could be adjusted by means of a micrometer screw, thus concealing almost entirely the junction of the two images.

Standard film can be projected by the central projector, the outside projectors merely running idle. The projected image in such case measures 14 × 10 meters, the brightness being about the same as in the case of panoramic projection. The distance between the projectors and the screen was approximately 60 meters. Projection occurred daily from 9:30 A.M. to midnight, and the apparatus operated quite satisfactorily.

REFERENCES

[1] LUMIÈRE, L.: "The Lumière Cinematograph," *J. Soc. Mot. Pict. Eng.*, **XXIV**(Dec., 1936), p. 640.

[2] DAIN, H.: "Memorandum on Widening the Field of Camera Lenses and the Use of Normal Films for the Panoramic Screen," *J. Soc. Mot. Pict. Eng.*, **XIX** (Dec., 1932), p. 522.

A 16-MM. STUDIO RECORDER*

R. W. BENFER**

For the past few years we have witnessed an increased use of 16-mm. sound-film by educators, advertisers, and industrialists as a medium for exploiting their respective subjects through non-theatrical distribution. Projector manufacturers have responded to this expansion with improved sound equipment to keep pace with the demand for quality of reproduction approaching that of the theatrical field. It remains, therefore, to improve the sound-track of these non-theatrical subjects in order that the benefits of contemporary effort in this field be realized to the fullest extent.

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** Electrical Research Products, Inc., New York, N. Y.

At the present time 16-mm. sound-prints are derived largely from 35-mm. subjects by the process of optical reduction, usually from a duplicate negative of the original. The printing losses inherent in this process have been calculated and verified by experiment so that, knowing the frequency characteristic of the original negative, an accurate estimation of the 16-mm. print characteristic can be made. It should be noted, however, that the 16-mm. reduction print is always a derivative of the original and its characteristic is governed by that of the original. The recorder described in this paper is the result of an investigation made to determine how far the restrictions imposed by reduction printing could be removed by directly recording on 16-mm. film. By utilizing the technical knowledge acquired in the 35-mm. field, Electrical Research Products engineers were able to design a recorder that will produce negatives the sound quality and frequency characteristic of which result in a much improved presentation of the subject as a 16-mm. release.

The recorder is intended primarily for studio use, and its design is such as to permit recording 16-mm. variable-density negatives, first, from direct pick-up; second, to re-record from 35-mm. prints; and third, to re-record directly from 35-mm. negatives through the recently developed negative playback system. Release prints are then obtained by contact printing the sound-track in combination with optical-reduction printing of the picture from the 35-mm. negative in accordance with established practice.

To render the machine versatile in its application to the different types of studio equipment with which it might be associated for these purposes, a synchronous tail-shaft speed of 1200 rpm. was selected to permit either direct coupling or electrical interlock to the the studio equipment. Two sprockets in the left-hand compartment (Fig. 1) are driven through worm-gear reduction from this shaft which completes the gear-driven system of the equipment. The film is exposed at the periphery of a film-driven kinetic scanner having an oil-damped flywheel, resulting in uniformity of film motion comparable to that of the latest 35-mm. recorder. Removable magazines with self-engaging couplings to the chain-driven take-up clutch and the feed-reel brake permit professional procedure in pre-loading magazines in accordance with studio practice.

The sound-track is of the variable-density type, recorded by means of the recently developed variable-intensity modulator, appearing in the right-hand compartment. The light-valve admits light to a fixed slit through a relay lens system resulting in a variable-intensity modulation of the light-beam. The slit, in turn, is imaged on the film through a 6:1 reducing objective, resulting in an image height of 0.4 mil at the film and giving an extinction frequency identical to that of a 1.0-mil image for 35-mm. film at 90 feet per minute. Since the film sees only a reduced image of a fixed slit, the effects of valve-ribbon velocity relative to the film velocity are eliminated, and the physical dimensions of the slit and spacing of the valve-ribbons enjoy liberal dimensional tolerances. Adequate design provisions have been included to permit accommodating any future types of modulator that may prove desirable.

A transparent deflector bleeds parts of the modulated light emerging from the slit and directs it to the photoelectric cell and monitor amplifier (Fig. 2) which provides sufficient output for high-quality headset monitoring. The light-valve input circuit shares the same compartment, and the oil-damped flywheel appears

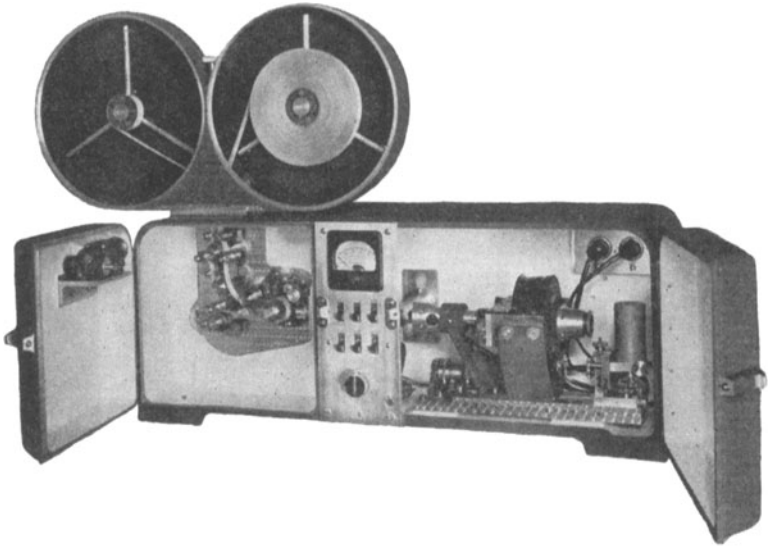

FIG. 1. Front view, doors open.

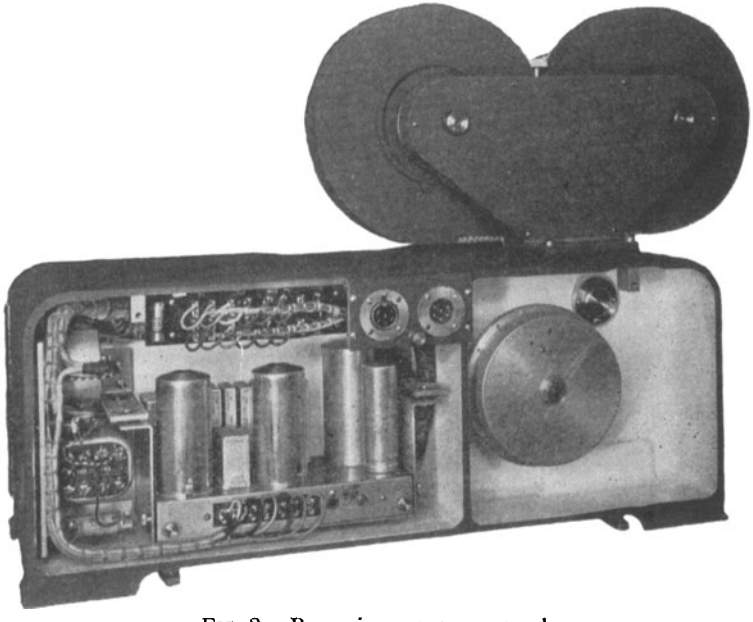

FIG. 2. Rear view, cover removed.

at the right. Both terminal strip and cord connectors are provided to accommodate whichever type of external wiring is desired. The monitor amplifier and the modulator, as well as the control panel, are all readily removable to give access to all wiring without disturbing the continuity of the circuits. The central control panel provides for all the conventional controls, including lamp, light-valve, and noise-reduction inputs.

Numerous experimental recordings have been made to determine the proper recording characteristic to result in a print characteristic having a pleasing frequency balance consistent with the inherent limitations of 16-mm. film, the speed of which is only 40 per cent of that of 35-mm. film. For direct pick-up, the pre-equalization characteristic has been made the inverse of the combined film and printing losses, so that the print shows a substantially flat characteristic to 6000 cycles per second, the higher frequencies being suppressed by a low-pass filter. For re-recording purposes it has been found desirable to determine the amount of pre-equalization not only from the standpoint of the film and printing losses but also from the characteristic of the original 35-mm. negative. By these processes it is possible to show a uniformity in the characteristic of the 16-mm. contact prints that is not always possible to attain by the optical reduction process.

DISCUSSION

MR. MCNABB: Approximately what equalization was used?

MR. BENFER: The recording channel was equalized to show a rising characteristic of about 8 to 10 db. at 6000 cycles, at which point the higher frequencies were suppressed by a low-pass filter.

MR. FRIEDL: I regard this as a very unusual demonstration of high-quality 16-mm. recording and reproduction. The question that occurs to me first is: Is a large part of that improvement due to the contact printing?

MR. BENFER: We have found that the prints from contact printers will have, as a rule, less flutter content than the print you get from the optical reduction process. That is not always the case, but it results in a more uniform product.

MR. FRIEDL: Is that because you used a specifically designed printer, say, a non-slip printer, whereas the optical prints are perhaps not made on equipment perfected to the same degree?

MR. BENFER: The only way I can answer that is to say these prints were made on a contact printer by DeLuxe Laboratories. We also made, for comparative purposes, optical reduction prints of the same subject, and the test of the two machines at this one laboratory showed that the contact printer was superior to the optical printer in terms of flutter.

MR. FRIEDL: That is optical printing from the 16-mm. negative?

MR. BENFER: No, from the 35-mm. negative.

MR. FRIEDL: The reason I bring this up is that I am again on a standards question. Contact printing normally places the emulsion on the positive on the side that we generally consider non-standard, or at least we would like to consider non-recommended practice.

You recall the confusion of 16-mm. standardization which caused this Society considerable concern and expense, and the final happy solution, as we consider it, of the international standardization on that subject.

For the sake of uniformity and simplicity we should try to keep the emulsion side for all 16-mm. sound prints on the side away from the light-source as normally viewed in a regular front projector. If contact prints are circulated with the emulsion on one side and optical reduction prints as made from 35-mm. are circulated with the emulsion on the other side, it is going to be very difficult to instruct, educate, or inform the non-technical user to adjust his reproducing equipment properly. Not only that, but it introduces an extra cost in the production of that apparatus, because you have to put on this scanning system a device permitting you to change the focus point of the scanning beam. In making a change like that, it would have to be a very precise adjustment, because the lens assemblies of 16-mm. designs are usually of cylindrical type, the light incident on the film being at a relatively steep angle. Therefore, any displacement from the actual focal plane will introduce losses in the high-frequency spectrum which we are so carefully trying to guard against.

MR. BENFER: You may have the impression that as we ran this film the emulsion was reversed according to the standards for optical reduction printing. That is not so. The sound-track printed by the contact-printing method from a negative to a positive print will agree with the SMPE standards for optical reduction printing. The picture, however, could not be contact-printed as taken by a 16-mm. camera. The picture must be optically printed from the 35-mm. negative. Through that combination of events you arrive at a film that agrees with the SMPE standards, and in support of your statement concerning the standards, if the point ever comes up to combine a direct contact print of both picture and sound negative, then the standards fail to agree and you come up against the obstacles of having to reverse one or the other.

MR. FRIEDL: There is a trick in the system. There is just a little flip-flop somewhere which must come out as you say. Do you record through the stock of the film?

MR. BENFER: No, the recorder exposes the film on the emulsion side in accordance with all conventions. The negative agrees with the SMPE standard "for special processes." The contact print obtained from that negative is contact-printed emulsion to emulsion and comes out with the sound-track in the proper direction when the emulsion is in the right position in accordance with the standards for optically reduced film. The picture must be optically printed from the 35-mm. negative to agree with that particular layout of emulsion and sound-track.

MR. KELLOGG: Do you get better resolution or high-frequency response on the 16-mm. film by contact printing than you can by direct optical reduction from the 35-mm. film, in sound-track production?

MR. BENFER: I am not prepared to say that. All other things being equal, with the same amount of perfection in each system, I believe they would be identical.

MR. KELLOGG: The advantages you mentioned of the contact printing then were confined to better propulsion?

MR. BENFER: That is the advantage as far as the two printers are concerned. Another advantage of contact printing is the ability to record a 16-mm. negative specifically for 16-mm. release, and to utilize the advantages you get from professional treatment on your original recording rather than to be restricted by the

characteristic that was put on the 35-mm. negative which was probably made for some other purposes than 16-mm. release.

MR. FRIEDL: Suppose the 35-mm. were made intentionally for optical reduction printing to 16-mm. in which event proper consideration could be given in the original recording, say, for example, raising the high end to compensate some for the printer loss, how would we come out?

MR. BENFER: I think you would come out nearly the same. We have taken both types of recording and compared both types of processes, and if you start originally with 16-mm. printing in mind, it is possible to obtain comparable prints from either process.

MR. FRIEDL: Then the advantage is what: the cost of the 16-mm. stock?

MR. BENFER: The advantage is that the present source of the 16-mm. subjects is 35-mm. film, and I doubt whether many of them were recorded with that in mind. Added to this is the fact that the optical-reduction process requires precision equipment and excellent maintenance to assure a uniform product. The straightforward process of contact printing results in uniform prints with a minimum of trouble.

MR. FRIEDL: That is a challenge to the manufacturers of optical reduction equipment.

MR. BENFER: As long as you ask me point blank, I will have to put it that way. It has taken seven years to get a good optical-reduction print but only seven weeks to get a good contact print, and we can repeat it from now on.

MR. FRIEDL: If you make this one 16-mm. negative from which you contact print, in order to make this commercial for wide distribution—I assume you have to make two negatives from that—then is the technic of making 16-mm. dupe negatives as well advanced as making 35-mm. dupe negatives?

MR. BENFER: That is a little out of my territory, but I think it is. We have been encouraged in this process by the laboratories themselves. They would rather attempt to perfect this type of practice than the other.

MR. FRIEDL: Is shrinkage for 16-mm. a limitation?

MR. BENFER: The shrinkage problem would be the same problem you have in 35-mm. and must be treated the same way.

MR. FRIEDL: 35-mm. negative is usually nitrate, whereas 16-mm. is acetate and can be made in nothing but acetate stock.

MR. BENFER: Perhaps we should ask the film suppliers for 16-mm. nitrate, since this is to be used in studios for negative purposes.

MR. FRIEDL: I am afraid you will not get that. Dr. Carver will confirm that, from our discussion in the Standards Committee.

DR. CARVER: I do not think there is any hope of getting 16-mm. nitrate. There is great fear that some of it will get into someone's home and set fire to it.

MR. BENFER: I can say one thing, the negative stock we have used has been acetate base. We have had no trouble with it through the laboratories on reprints. This demonstration negative is a composite negative, some sections of which were taken almost a year ago. The print you heard here was printed last week, from a combination of the negatives that have been recorded during the past year. We have had no complaint either from the results we have experienced ourselves or from the laboratory in handling it on the basis of shrinkage or anything of that nature on the acetate-base 16-mm. film.

MR. DEPUE: If you have a very fine and expensive production, would you risk making just one negative on 16-mm?

Six years ago the company with which I am connected made direct recordings of voice—not music but voice—that have been holding up very well. Prints have been made from it just recently, and there has been no trouble, but we have always been fearful that, if anything should happen to the negative we should have nothing to go back to. If we had a standard size we would reproduce and make another negative.

MR. BENFER: If the 16-mm. field is to grow and assume a professional aspect, then all conventions and things found advantageous to the professional field should be adhered to in the 16-mm. field. When the production is of sufficient importance to warrant duplicate negatives taken simultaneously, the same procedure could be followed in the 16-mm. field. This recorder is an attempt to give the 16-mm. industry the facilities for professional recording and distribution of its product.

A NEW SINGLE-SYSTEM RECORDING ATTACHMENT FOR STANDARD CAMERAS*

A. REEVES**

When sound was first introduced, it was believed that there existed but two possible classes of users of sound-camera equipment: the studio, which could use a large permanent or semipermanent double-film recording installation; and the travelling cameraman, best exemplified by the newsreel cameraman, whose ends seemed best served by a portable, single-film sound-and-picture recording camera.

During recent years it has been found that there is another important group, the specialized needs of which have as yet received little attention. This group comprises those who use direct-recorded sound, but need to use it only occasionally, being able to film much of their footage silent and later "dub in" whatever sound, narration, or music may be necessary. This group includes many newsreel cameramen (for fully half of today's newsreel scenes are made silent, and later dubbed to a narrative or musical sound background); the makers of travel-films; many makers of commercial, industrial, or educational films; studio cameramen sent to distant locations for the making of process backgrounds; and the very considerable army of owners of professional silent picture cameras whose work does not warrant the discarding of their expensive silent picture equipment or the purchase of conventional sound equipment. All of them could make use of direct sound recording if it did not involve an undue amount of bulky added equipment.

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** Art Reeves Motion Picture Equipment Co., Hollywood, Calif.